DOCUMENT RESUME

ED 221 390 SE 039 202

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TITLE Centrifuge. Operational Control Tests for Wastewater Treatment Facilities. Instructor's Manual [and] Student Workbook.
INSTITUTION Linn-Benton Community Coll., Albany, Oreg.
SPONS AGENCY Office of Water Program Operations (EPA), Cincinnati, Ohio. National Training and Operational Technology Center.
PUB DATE Aug 81
GRANT EPA-900953010
NOTE 29p.; Slide/tape program which accompanies this module is also available from Linn-Benton Community College.
AVAILABLE FROM Linn-Benton Community College, 6500 S.W. Pacific Blvd., Albany, OR 97321 ($1. student workbook, $2. instructor's guide).

EDRS PRICE MF01 Plus Postage. PC Not Available from EDRS.
DESCRIPTORS Instructional Materials; *Laboratory Procedures; Postsecondary Education; *Sludge; Teaching Guides; *Training Methods; *Waste Water; *Water Treatment
IDENTIFIERS Centrifuge Test

ABSTRACT

Designed for individuals who have completed National Pollutant Discharge Elimination System (NPDES) level 1 laboratory training skills, this module provides waste water treatment plant operators with the basic information needed to: (1) successfully run a centrifuge test; (2) accurately read results obtained in test tubes; and (3) obtain consistent results from the test procedure. The instructor's manual contains a statement of the instructional goal, lists of instructor/student activities and instructional materials, narrative of the slide/tape program used with the module, overhead transparency masters, and student worksheet (with answers). The student workbook contains objectives, prerequisite skills needed before the module is started, sources of centrifuges and centrifuge tubes, laboratory procedures used to estimate the suspended solids concentration in samples taken from any part of a treatment plant, and worksheet. (Author/JN)

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Operational Control Tests

for Wastewater Treatment Facilities

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Centrifuge

Instructor's Manual

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Linn-Benton Community College
Albany, Oregon

CENTRIFUGE

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Developed Under:
EPA Grant #900953010
August, 1981

CENTRIFUGE

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INSTRUCTIONAL GOALS

Upon completion of this lesson the student should be able to successfully run the centrifuge test and accurately read the results obtained in the test tubes.

INSTRUCTOR ACTIVITY

For best results follow this sequence:

	Activity	Time
1.	Review objectives with the students.	5 minutes
2.	Assign the reading of the procedures.	10 minutes
3.	View the slide program.	10 minutes
4.	Discuss the concept of ultimate compaction. (See Appendix A for details)	10 minutes
5.	Demonstrate the test procedure.	15 minutes
6.	Assign worksheet.	10 minutes
7.	Correct worksheet.	5 minutes
8.	Have students perform the test.	25 minutes

Other Activities:

The above sequence should be followed if there is ample time. If time is short and if the students have already developed and displayed good lab skills the demonstration may be skipped.

If you intend to give the demonstration you should point out the following:

1) Emphasize safety problems associated with lifting the lid while the centrifuge is running.
2) Show how to check the pads to make sure they will give adequate protection to the tubes.
3) The filling procedure and the need to obtain 100% volume.
4) The process of quickly removing any excess sample.
5) The drying of the tubes.
6) How to check to make sure that the tubes are not too long.
7) And how to clean the tubes.

You may want to prepare several tubes with different sludge volumes. These could be passed around the class for observation in reading the sludge level.

If you do not wish to use real tubes or if the class is too large use the overhead in Appendix B and a visa-visa pen to show different sludge levels. Color in a level with the pen and then have the students read the value. Point out that we read to the nearest ½ percent below 10% and to the nearest percent when above 10%.

Be sure to point out that the answers are expressed in % volume and cannot be directly related to mg/l. A student may have previous data for a particular plant that has been used to develop a % spin to mg/l curve. Point out that this curve will change with a change in sludge age.

For more information on the degree of compactibility of sludges in reference to sludge age see the A1 West pamphlet on Activated Sludge Calculations Part III available from NTOTC.

STUDENT ACTIVITY

1. Read objectives
2. Read procedures.
3. View the slide program.
4. Complete worksheet.
5. Perform test.
6. Record data.

INSTRUCTIONAL MATERIALS LIST

1. Instructor Guide for Centrifuge
2. Student Workbook for Centrifuge
3. Procedures Manual for Operational Control Tests
4. 35mm projector
5. Cassette tape player with automatic synchronization
6. Projector Screen
7. Overhead Projector
8. Equipment listed in the lab procedures

NARRATIVE

Slide #

1. The determination of solids concentration by centrifucation. This lesson discusses equipment and procedures used.

2. The lesson was written by Mr. E. E. Arasmith. The instructional development was done by Priscilla Hardin. Dr. John W. Carnegie was the project manager.

3. A fast, repeatable means of determining the concentration of solids at various points within the treatment facility has always been an operational need.

4. A common method of making this determination is with the use of a centrifuge.

5. The goal of this test is to separate the solids from the liquid and achieve a quick visual determination of the amount of solids present within the sample.

6. This is done by placing a sample in a centrifuge and spinning it long enough and fast enough to reach ultimate compaction.

7. Let's take a look at the equipment that is commonly used to perform this test. The major component is a clinical centrifuge with a swinging bucket.

8. We also need centrifuge tubes that are 12½ ml, graduated in percent, an electric timer, and a few pasteur pipets with bulbs, along with some clean tissue and the proper data sheets.

9. The procedure can be divided into four basic steps. Collection and preparation of the sample, the test procedure, recording the data, and cleaning the tubes. Let's take a closer look at each of these steps.

10. First, is the collection and preparation of samples. Sample volumes of at least 50 ml should be collected and tested immediately.

11. The time from collection to testing should not exceed 15 minutes.

12. If the sample is held too long the results of the test will be inaccurate. Why? Well, these are usually biological sludges that are being tested, and biological sludges are under constant change. Removing them from their environment accelerates this change.

13. If the centrifuge test is being conducted in conjunction with the settleometer test, the centrifuge and the settleometer samples should be collected from the same container.

14. After the samples arrive at the lab, they should be thoroughly but gently mixed. Remember, this may be a biological sludge and violent agitation could change its compactability.

15. Using the mixed sample, rinse the centrifuge tubes twice.

16. After rinsing, we are ready to proceed to step two, the procedure itself.

17. The test involves placing a portion of sample in a centrifuge tube, placing the tube in the centrifuge and then spinning the tubes for 15 minutes. The tubes are then read and the data recorded.

18. Remix the sample. And then, to prevent settling, quickly pour the sample so that the bottom of the meniscus is at the 100% mark.

19. It is better to overfill the tube and shake off the excess or remove the excess with a pasteur pipet then to refill or slowly fill the tube.

20. To reduce the risk of breakage, the outside of the tube should be thoroughly cleaned and dried.

21. All tubes in the centrifuge should be either filled with sample or clear water. Doing so will reduce vibration and breakage.

22. Close the lid, set the speed control to maximum, set the timer for 15 minutes, and turn on the centrifuge.

23. Do not open the lid during operation of the centrifuge. If a tube should break while the centrifuge is running and you open the lid, you could receive a face full of glass.

24. After the centrifuge has come to a complete stop, remove the tubes and determine the solids concentration by reading the scale at the top of the sludge.

25. The size of the graduations on the tube allows more precise reading for smaller amounts of solids. Above 10%, the solids can be read to the nearest 1%. Between 3% and 10% the solids can be read to the nearest ½% and below 3% can be read to the nearest 0.1%.

26. Here are a few examples: This tube would read 1.8%.

27. Here is another example: What value do you read? The value you got should be close to 4%.

28. And finally, here's a third example. What value do you see? Yes, the tube reads 7%.

29. Now record the data on the proper data sheet.

30. After the data has been recorded, the centrifuge tubes should be cleaned.

31. This can be accomplished by inserting a pasteur pipet into the tubes and flushing the compacted solids with water.

32. The tubes should then be rinsed with clean water and placed in a rack to dry.

33. CAUTION: The results are in percent volume by centrifuge spin. This value should not be converted directly to milligrams per liter. This is due to the variations in compactability of different types and ages of sludge.

34. Two common problems periodically occur in the centrifuge test. The most common is the breakage of the centrifuge tubes. The second is that the solids that are compacted in the bottom of the tube might be at a slant. Let's look for a moment at the most common causes of these problems.

35. As we mentioned, the most common problem is the breakage of tubes. If this is a persistent problem you may want to check the following: First, check the pads to see if they are missing or damaged.

36. Then check the length of the tubes to see if they miss the head when they swing straight out.

37. You should also check the insides of the shields and the outsides of the tubes to be sure that they are totally dry.

38. The other major problem is slanting solids in the tip of the tube. If this problem occurs check the RPM's, because it may not be coming up to maximum speed. There also may not be enough room for the head to swing straight out.

39. During this procedure we have discussed the equipment necessary to perform this test.

40. We followed the basic procedure of placing a sample in a test tube, cleaning and drying the tube, and placing the tube in the centrifuge and spinning for 15 minutes.

41. The tube was then read and the results recorded in percent solids by centrifuge spin.

42. You are now ready to use the centrifuge test to determine solids concentration on samples from any point in the plant.

APPENDIX A

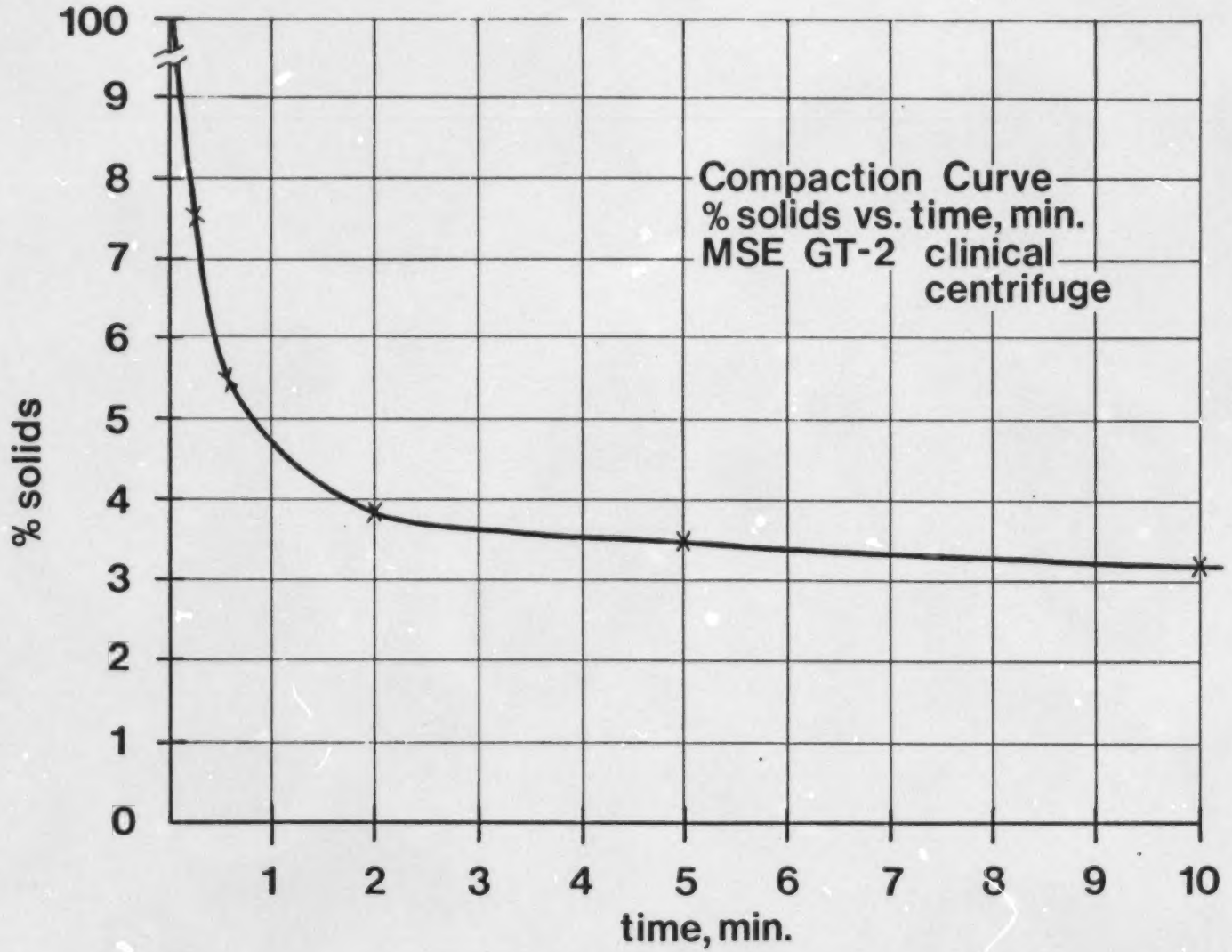
For use with the overhead on the next page.

It is not intended that each student perform this test in conjunction with all sludges. Merely point out that the process of ultimate compaction is the desired results of the test.

Ultimate compaction is relative to the type and age of sludge being handled. (See Al West pamphlet Part III from NTOTC on the effect age of Activated Sludge has on compaction.)

Very little data is available on other types of sludge and the effect age may have on the time and RPM necessary to give ultimate compaction.

The student should be encouraged to develop such data on other sludge within their plants.


100
9
8
7
6
5
4
3
2
1
0
% solids
1
2
3
4
5
6
7
8
9
10
time, min.
Compaction Curve
% solids vs. time, min.
MSE GT-2 clinical
centrifuge

APPENDIX B

12.5 ml Centrifuge Tube

CENTRIFUGE TEST

WORKSHEET

Directions: Place an "X" by the best answer. There is only one best answer for each question.

1. The major purpose for the centrifuge test is to:

   a)_____ find the concentration of mixed liquor.

   b)__X__ obtain quick reliable estimates of suspended solids concentration.

   c)_____ estimate sludge dewaterability.

   d)_____ simulate the compacting that may be reached in a clarifier.

   e)_____ None of the above.

2. The centrifuge test is based on an assumption that the sludge in the test tube has been spun long enough and fast enough to reach:

   a)_____ a stabilized condition.

   b)_____ ultimate settleability.

   c)_____ ultimate separation.

   d)__X__ ultimate compaction.

   e)_____ All of the above.

3. The centrifuge gives sludge concentrations in:

   a)__X__ percent.

   b)_____ mg/l

   c)_____ ppm

   d)_____ ml/ml

   e)_____ None of the above.

4. The type of centrifuge commonly used for this test is referred to as a _____ centrifuge.

a)_____ ultra

b)_____ high speed

c)_____ fixed head

d)_____ laboratory

e)__X__ clinical

5. Which item in the list below is <u>not</u> part of the centrifuge test procedure?

a)_____ spin for 15 minutes

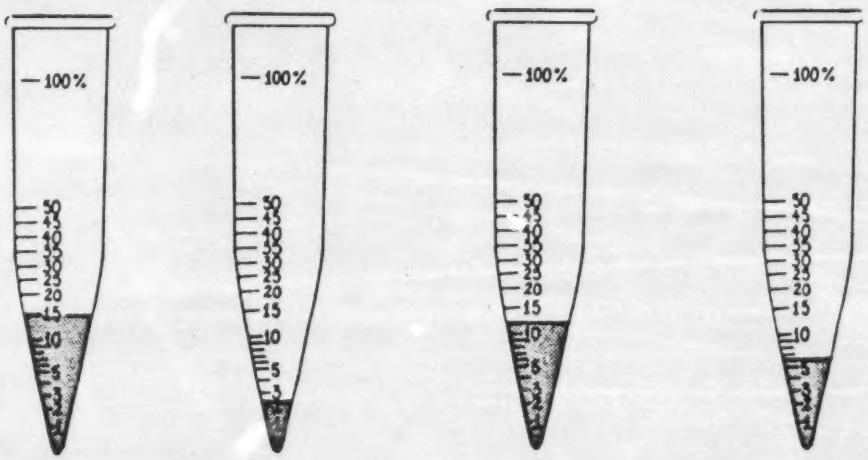
b)__X__ rinse tube with distilled water before spin.

c)_____ place tubes in centrifuge

d)_____ collect 50 ml sample

e)_____ clean tubes

6. Record the results of the centrifuge spins:



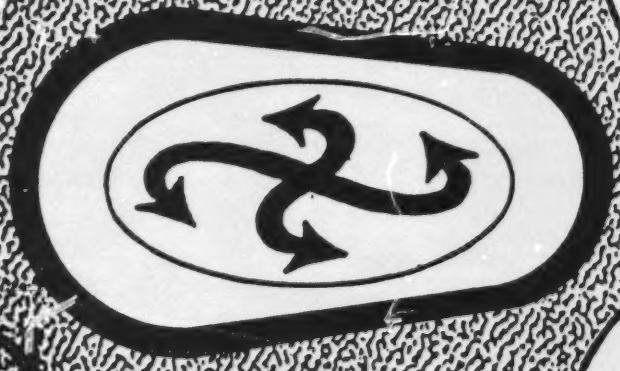
a)__15%__ b)__2.5%__ c)__12.5%__ d)__6%__

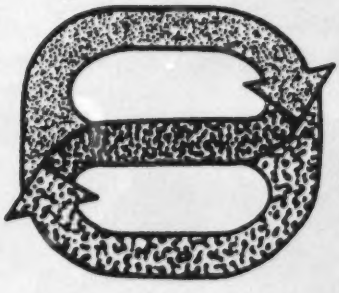
Operational Control Tests

for Wastewater Treatment Facilities

Centrifuge

Student Workbook





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CENTRIFUGE

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CENTRIFUGE

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INTRODUCTION

This module on solids determination by centrifugation is intended to give the operator the basic information necessary to obtain reliable consistent results from the test procedure.
The mention of any brand names should not be taken as an endorsement of that material.
This module is intended to be used by individuals who have completed NPDES level I Laboratory skills training.

OBJECTIVES

Upon completion of this module you should be able to:

1. Describe the purpose of the centrifuge test.
2. Recall that the test gives results in percent.
3. Describe the type of centrifuge to be used.
4. Describe the centrifuge test.
5. Accurately read a centrifuge tube.
6. Perform the test procedure.

PREREQUISITE SKILLS

In addition to the skills listed in the introduction the following skills are needed for this test:

1. Familiarity with the use of a centrifuge.
2. Ability to use a timer clock.

RESOURCE LIST

Centrifuge may be purchased from:

1. Scientific Products
   3660 148th Ave., N.E.
   Redmond, WA 98052
   206-885-4131
   Clinical Centrifuge
   #C 1450-1

2. VWR Scientific, Inc.
   P.O. Box 13007, Station K
   Atlanta, GA 30324
   404-262-3141
   Kimax Centrifuge Tube
   #45170

Centrifuge tubes may be purchased from:

1. Arthur H. Thomas Company
   Vine Street at 3rd
   Philadelphia, PA 19106
   215-574-4500

   Nalgene Settleometer and Centrifuge Kit #9857-V25

2. VWR Scientific, Inc.
   P.O. Box 13007, Station K
   Atlanta, GA 30324
   404-262-3141

   Kimax Centrifuge Tube #45170

Further information on the performance of this test may be found by obtaining the following written material:

1. Operational Control Procedures for the Activated Sludge Process, by Al West, available from US EPA - NTOTC Cincinnati, Ohio 45268.
2. Procedures used in Conducting Selected Activated Sludge Control Test, by Owen Boe, available from Linn-Benton Community College, Albany, Oregon 97321.

CENTRIFUGE TEST

INTRODUCTION

The centrifuge test can be used to estimate the suspended solids concentration in samples taken from any part of the treatment plant. It has commonly been used to obtain a quick, reliable estimation of the suspended solids concentration of the mixed liquor in the aeration basin, return sludge from the final clarifier, and waste sludge removed from the activated sludge system.

EQUIPMENT

Centrifuge	clinical with swing-out head
Centrifuge tubes	(Kimax centrifuge tubes, Kimble #45170, 12.5 ml, graduated 0 - 100% or equivalent)
Timer	(Electric Gralab, Model 300 or equivalent)
Pasteur pipet and bulb	

PROCEDURE

1. COLLECT SAMPLE.

   Collect at least 50 ml of sample for the centrifuge spin. If settlement test is being conducted in conjunction with the centrifuse, the samples should be taken from same collection container.

2. MIX SAMPLE. The sample which is to be poured into the test tubes should be gently, but well mixed. Don't shake the sample.

3. RINSE TEST TUBE.

   Rinse the test tube with sample by filling the test tube about half full. Swirl the sample in the tube and dump contents of the test tube into sink.

4. POUR SAMPLE INTO TEST TUBE.

   Mix the sample again, fill the test tube with sample so that the bottom of the meniscus is on the 100% mark of the test tube. Samples should be poured quickly to prevent settling in the sample collection container.

5. CLEAN OUTSIDE OF TEST TUBE.

Wipe the excess water from the outside of the tube. Failure to clean the outside of the test tube may cause it to break.

6. PLACE TEST TUBE IN HOLDER.

Make sure that filled tubes are placed opposite one another. If the centrifuge is not balanced, it will shake severely, break test tubes, and shorten the life expectancy of the centrifuge.

Any test tube that is not being used in the test should be filled with water. This results in even loading on the centrifuge in every run, thus assuring a relative constant speed in rpm's in all cases.

7. SPIN AT HIGH SPEED FOR 15 MINUTES.

It is suggested that an automatic timer be used in conjunction with the centrifuge so that the centrifuge will automatically shut off after 15 minutes.

8. READ AND RECORD.

After the test tube has spun at high speed for 15 minutes, read and record the percent volume of packed solids.

9. CLEAN TEST TUBES.

The centrifuge test tubes are difficult to clean because of the packed solids that concentrate in the bottom of the tubes. These tubes must be thoroughly cleaned before they are used again or inaccurate test results will occur. Cleaning can be accomplished by using a Pasteur pipet and forcing clean water into the bottom of the tube to dislodge the solids.

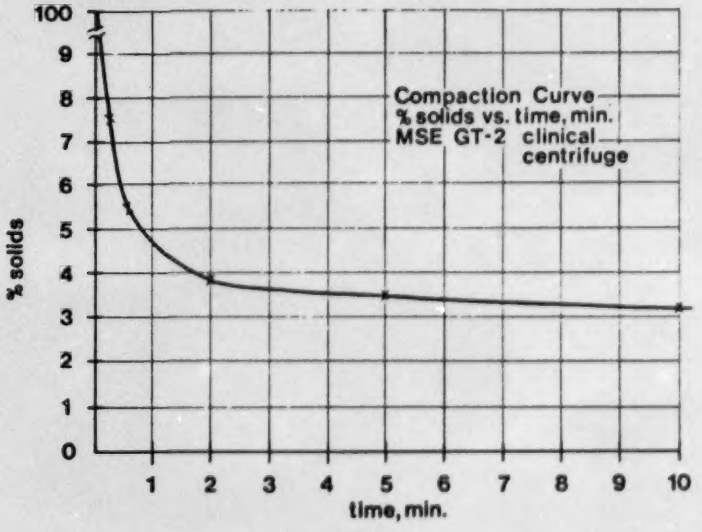
CALCULATIONS

This test gives the suspended solids concentration in "percent volume by centrifuge spin." This value should not be converted directly to mg/l suspended solids because of variations in compactability of different types and ages of sludge.

SUPPLEMENTARY MATERIAL

The centrifuge procedure calls for obtaining ultimate compaction of the tested sludge. If you are not certain that the test sample you are working with is reaching ultimate compaction you may want to run the following test:

1. Obtain a sample of sludge.
2. Run a series of centrifuge spins at one minute intervals on different portions of the sample. (Keep the RPM the same for all spins.)
3. Plot the results against time:



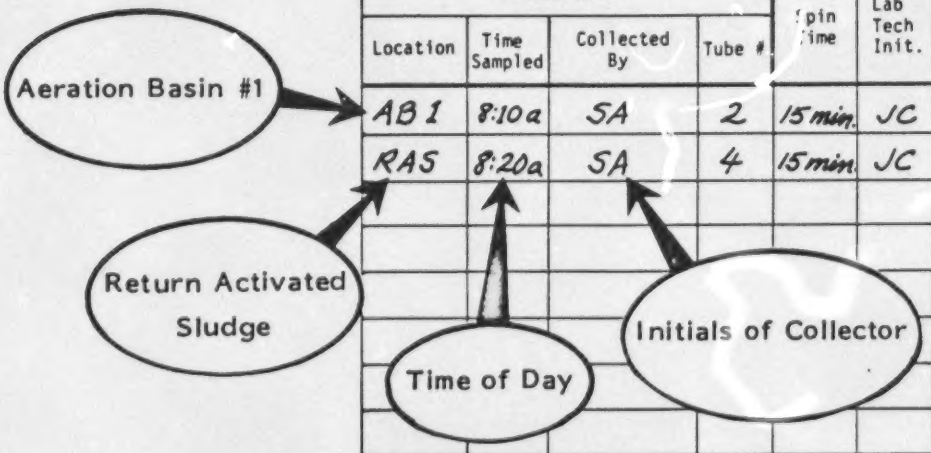
4. Ultimate compaction is reached for this RPM setting when the curve levels off.
5. If your centrifuge is variable RPM you may wish to hold the time at 15 minutes and vary the RPM to obtain the same point.

Average Ranges for Various Process Units:

Mixed Liquor	0.5 - 5%
Return Sludge	1 - 15%
Raw Sludge	N.A.
Centrifuge Sludge	3 - 20%
Anarobic Digested Sludge	N.A.
Aerobic Digested Sludge	N.A.
Flotation Thickened Activated Sludge	N.A.

CENTRIFUGE TEST DATA						DATE _____	
SAMPLE DATA				Spin Time	Lab Tech Init.	Remarks	%
Location	Time Sampled	Collected By	Tube #				

SAMPLE DATA SHEET



CENTRIFUGE TEST DATA — DATE 7-31-

SAMPLE DATA				Spin Time	Lab Tech Init.	Remarks	%
Location	Time Sampled	Collected By	Tube #				
AB 1	8:10a	SA	2	15 min.	JC	Storage time:	2.5
RAS	8:20a	SA	4	15 min.	JC	1 hr. in ref.	10

PROCEDURE SUMMARY

PROCEDURE	CALCULATIONS
1. Collect sample (50 ml)	1. Results read directly in %
2. Mix sample	
3. Rinse test tubes with sample	
4. Fill tubes	
5. Clean and dry tubes	
6. Place tubes in centrifuge	
7. Spin for 15 minutes	
8. Read and record	
9. Clean test tubes	

Centrifuge

The above procedure summary is designed as a laboratory aid. It may be cut out and attached to a 5" X 7" index card for convient reference at the laboratory bench. To protect the card you may wish to cover it, front and back, with clear, self-adhesive shelf paper or similar clear material.

CENTRIFUGE TEST

WORKSHEET

Directions: Place an "X" by the best answer. There is only one best answer for each question.

1. The major purpose for the centrifuge test is to:

   a)_____ find the concentration of mixed liquor.

   b)_____ obtain quick reliable estimates of suspended solids concentration.

   c)_____ estimate sludge dewaterability.

   d)_____ simulate the compacting that may be reached in a clarifier.

   e)_____ None of the above.

2. The centrifuge test is based on an assumption that the sludge in the test tube has been spun long enough and fast enough to reach:

   a)_____ a stabilized condition.

   b)_____ ultimate settleability.

   c)_____ ultimate separation.

   d)_____ ultimate compaction.

   e)_____ All of the above.

3. The centrifuge gives sludge concentrations in:

   a)_____ percent.

   b)_____ mg/l

   c)_____ ppm

   d)_____ ml/ml

   e)_____ None of the above.

4. The type of centrifuge commonly used for this test is referred to as a _____ centrifuge.

   a)_____ ultra

   b)_____ high speed

   c)_____ fixed head

   d)_____ laboratory

   e)_____ clinical

5. Which item in the list below is <u>not</u> part of the centrifuge test procedure?

   a)_____ spin for 15 minutes

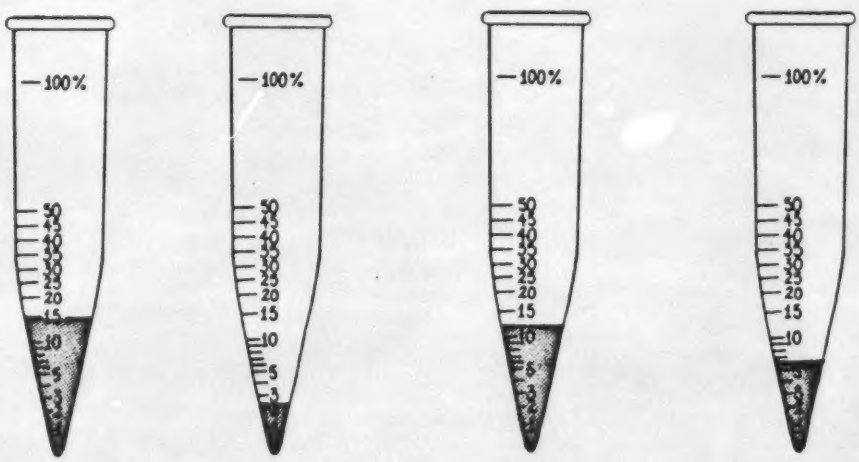
   b)_____ rinse tube with distilled water before spin.

   c)_____ place tubes in centrifuge

   d)_____ collect 50 ml sample

   e)_____ clean tubes

6. Record the results of the centrifuge spins:



a)_____ b)_____ c)_____ d)_____